REPORT ON THE COOPERATIVE MINERAL EXPLORATION IN THE MACDOUGALL AREA THE REPUBLIC OF ZIMBABWE

PHASE II

MARCH 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

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REPORT ON THE COOPERATIVE MINERAL EXPLORATION IN THE MACDOUGALL AREA, THE REPUBLIC OF ZIMBABWE PHASE II MARCH 1991

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P R E F A C E

In response to the request the Government of Zimbabwe, the Japanese Government decided to conduct a Mineral Exploration in the MaCdougall Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to Zimbabwe a survey team headed by Mr. Fumio Wada from 9 July to 10 October, 1990.

The team exchanged views with the officials concerned of the Government of Zimbabwe and conducted a field survey in the MaCdougall area. After the returned to Japan, further studies were made and the present report has been prepared.

We hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

We wish to express our deep appreciation to the officials concerned of the Government of Zimbabwe for their close cooperation extended to the team.

February 1991

Kensuke YANAGIYA
President
Japan International Cooperation Agency

Gen-ichi FUKUHARA
President
Metal Mining Agency of Japan

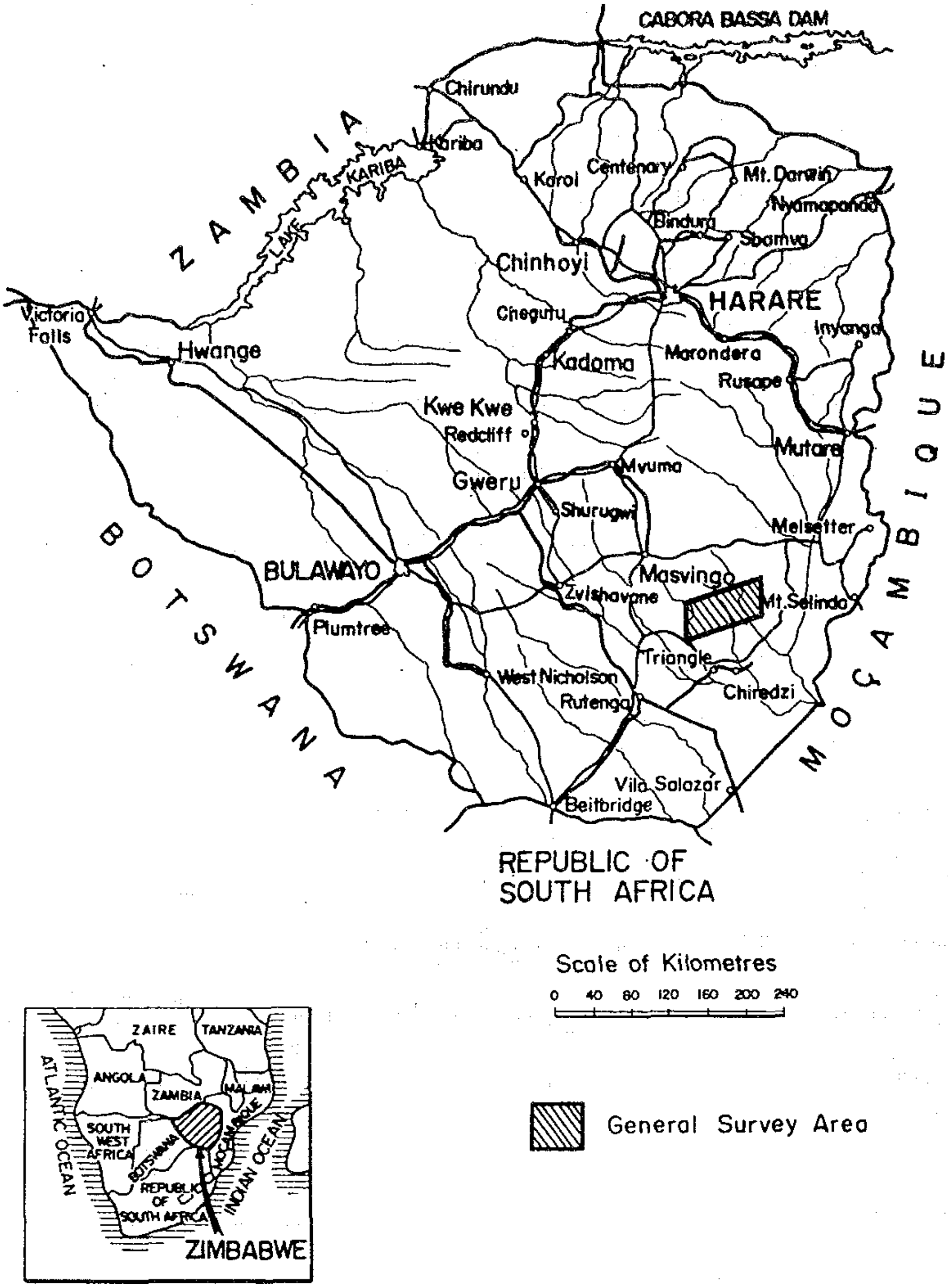


FIG. G-1 Location of the Macdougall Area, Zimbabwe

S U M M A R Y

This year, the second year of the cooperative mineral exploration in the Republic of Zimbabwe, a geological survey and geochemical survey were carried out. A summary of the survey is described below.

Geological Survey: The survey area is located in the Northern Marginal Zone (NMZ) of the Limpopo Mobile Belt, which stretches from ENE to WSW, dividing Zimbabwe Craton from Kaapvaal Craton. The NMZ is 30 to 40 km wide at the section which is in contact with Zimbabwe Craton. The area consists of the following geological units:

(1) Gneissose granulite : (high metamorphic rock)
(2) Felsic granulite : (high metamorphic rock)
(3) Mafic granulite : (high metamorphic rock)

Iron information and dolerite are also observed.

The geological structure of the survey area is characterized by the foliation of the ENE-WSW (N60-70E) system. Foliation is generally considered as a south dip, but in the south of the survey area, north dip foliation is also observed showing a highly folded form. The survey area is divided into four main blocks according to principal tectonic lines (Zazaume-Makambe tectonic line, Vurumuku tectonic line, and Murerezi tectonic line), and these blocks are thought to be subjected to ascending and descending block movements.

From the first year's survey, respective areas estimated as promising Au zones were selected as described below.

REASON FOR SELECTION	NUMBER OF AREA	EXTENT(km^2)
ANOMALOUS AREA INDICATED BY MULTIPLE SAMPLES	10	349
ANOMALOUS AREA INDICATED BY SINGLE SAMPLE	2	137
ANOMALOUS AREA INDICATED BY PANNED SAMPLE	7	14
T O T A L	10	500

Nine zones shown in the following table were selected after semi-detailed geochemical survey from these areas, noting the conditions of mineralized signs (sulphides, Fe-hydroxides, quartz vein/stockwork, pegmatite quartz and K-feldspar).

There is poor relation of indicator contents between the samples from mineralized zones (Juwere mineralized zone, Jegede mineralized zone, Muchacha

mineralized zone, etc.) accompanied by sulphides confirmed by this semi-detailed geological survey, and the contents of the indicators from the surrounding soil samples. It was found that anomalous values in the soil samples are apt to contain a higher Au content than values in the samples from the mineralized zones. It may suggests that the mineralized zones have been subjected to weathering.

Geochemical Survey : Soil samples (B-horizon) of 10,047 were collected from the nine zones of the following table selected by the geological survey, and analyses related to Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni and Fe were carried out.

ZONE	BASE LINE(M)	SAMPLING LINE(M)	SOILS
JUWERE	1,500	2,970	1,560
JEGEDE	2,500	1,470	1,277
MUCHACHA	2,500	1,020	907
BENZI	2,000	1,020	728
RUPIRI	3,800	1,470	1,593
CHIPFUNDE	3,200	1,200	898
FUMURE	2,000	1,260	696
NYAHONDO	2,200	1,680	1,057
CHAMBURUKIRA	1,900	2,190	1,331
TOTAL			10,047

By considering the direction in which mineralized signs and a principally related geologic units thought to be associated with mineralization extend, the directions of the soil collection lines, except for the Juwere zone (Juwere mineralized zone is observed as roughly N-S system), were set at a direction of N-S system because in the zone's geological structures an ENE-WSW system prevails.

The analytical results of collected soil samples were interpreted by single variate analysis and multivariate analysis so that the geochemical characteristics of the geological units from which the samples originated could be determined.

From the results, the following three zones

(1) Jegede zone

(2) Benzi Zone

(3) Fumure Zone

can be judged as promising because of

(1) the stable and continuous distribution,

(2) high Au value

(3) clear contrast

etc. in the geochemical anomalous zones regarding Au in each zone. On the other hand, the following two zones are proposed as targets of IP survey to confirm for their continuation of sulphide mineralization.

(4) Juwere Zone

(5) Muchacha Zone

Ag contents, and other elements in the mineralized zones in the surveyed zones, were generally low and limited extent. The appearance of geochemical anomalous zones was more scattered than that of Au, and a correlation among indicators was poor, so that no promising anomalous zones of Ag and other elements were found.

On the basis of a comprehensive interpretation regarding the survey results described above, we think that for sites proposed for the third year exploration, promising Au mineralized zones must be confirmed by confirming the presence of sulphide minerals expected in the zones using a geophysical survey(IP method) of the three geochemical anomalous zones and two mineralized zones, and then conducting a drill survey according to the investigated results.

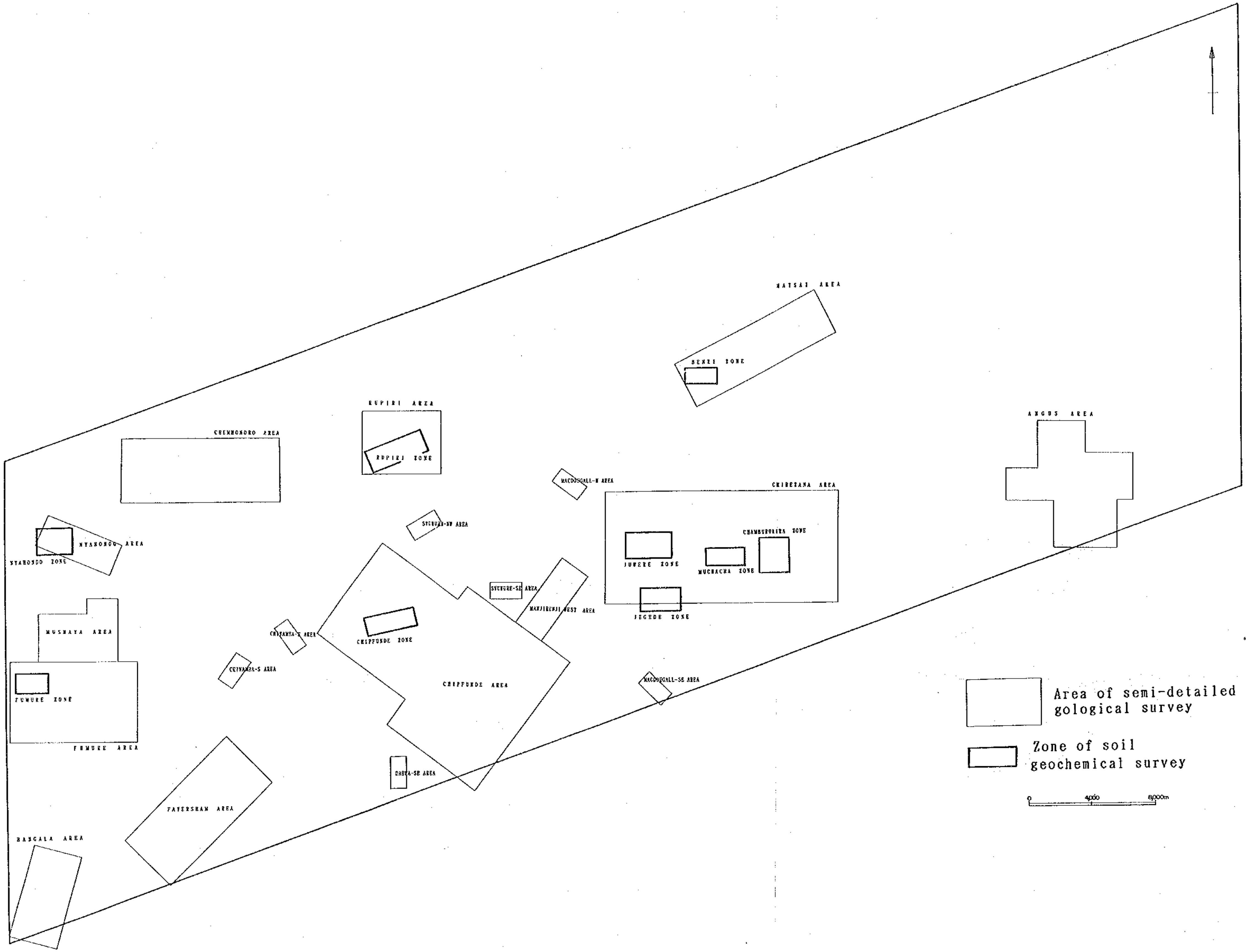


FIG. G-2 Locality Map of Survey Area

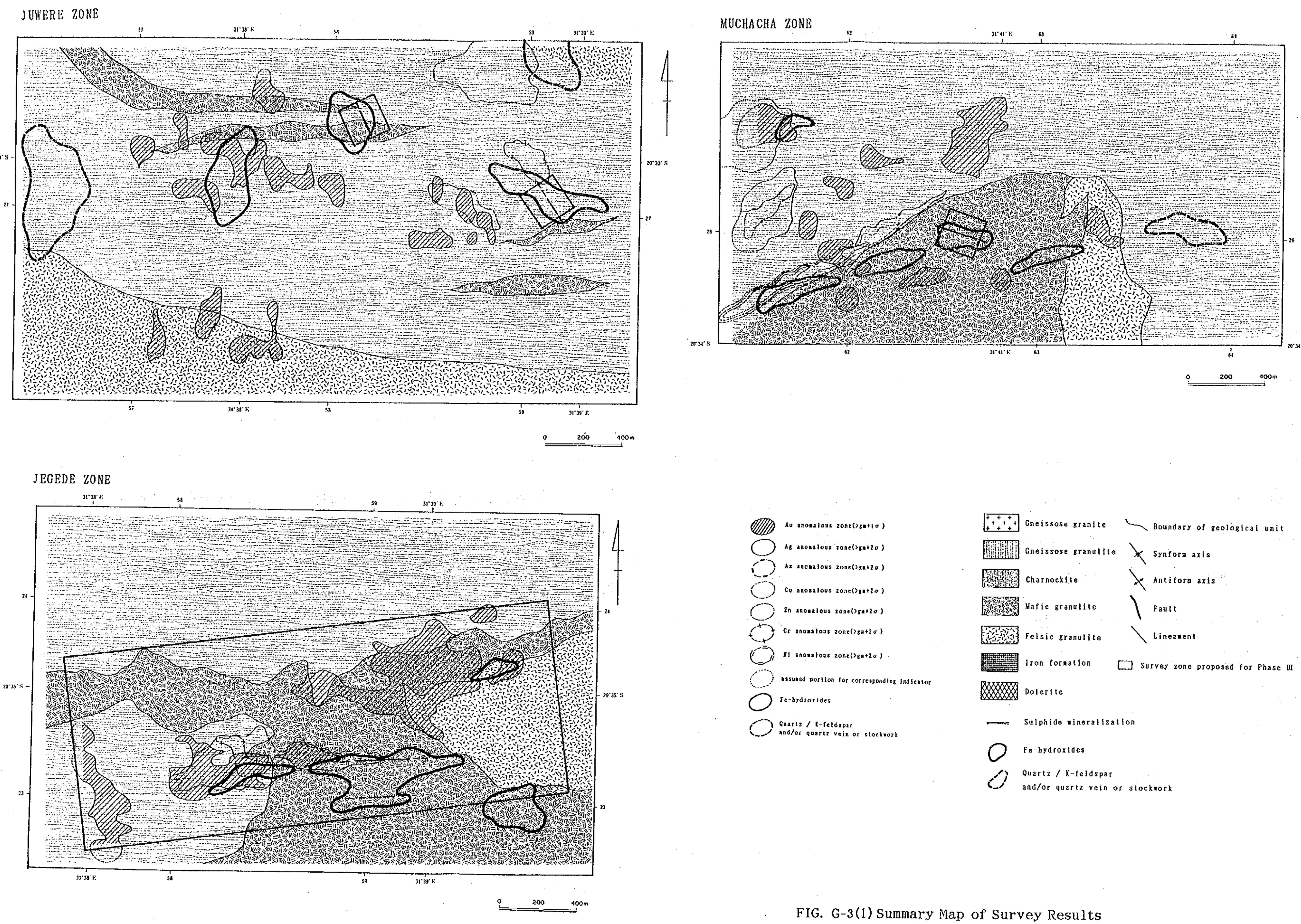
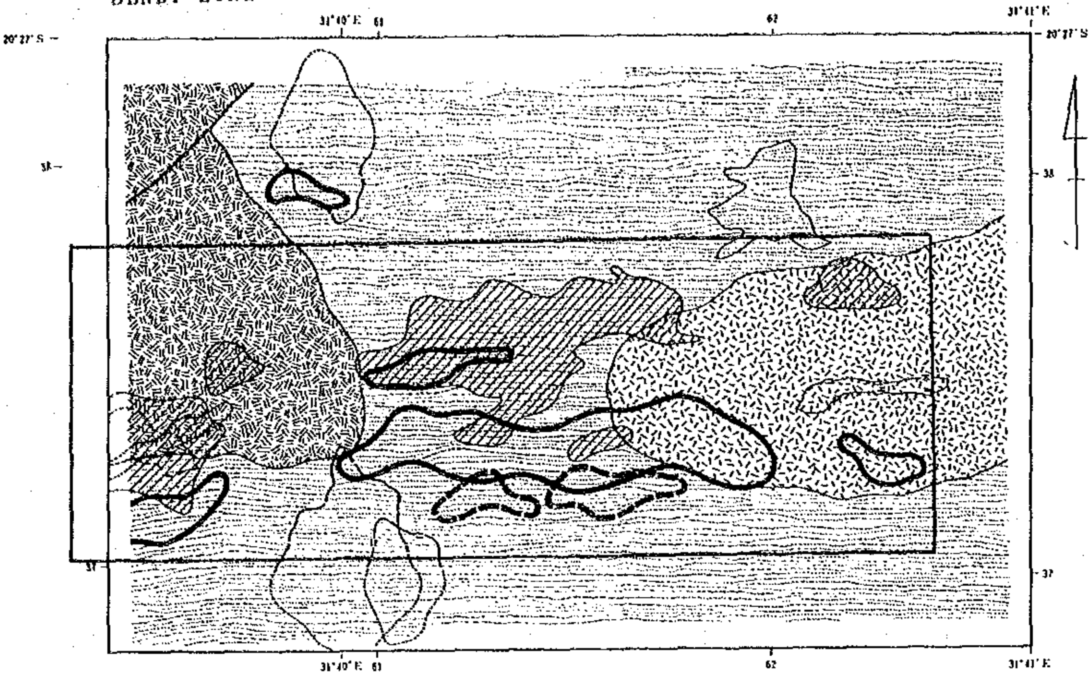
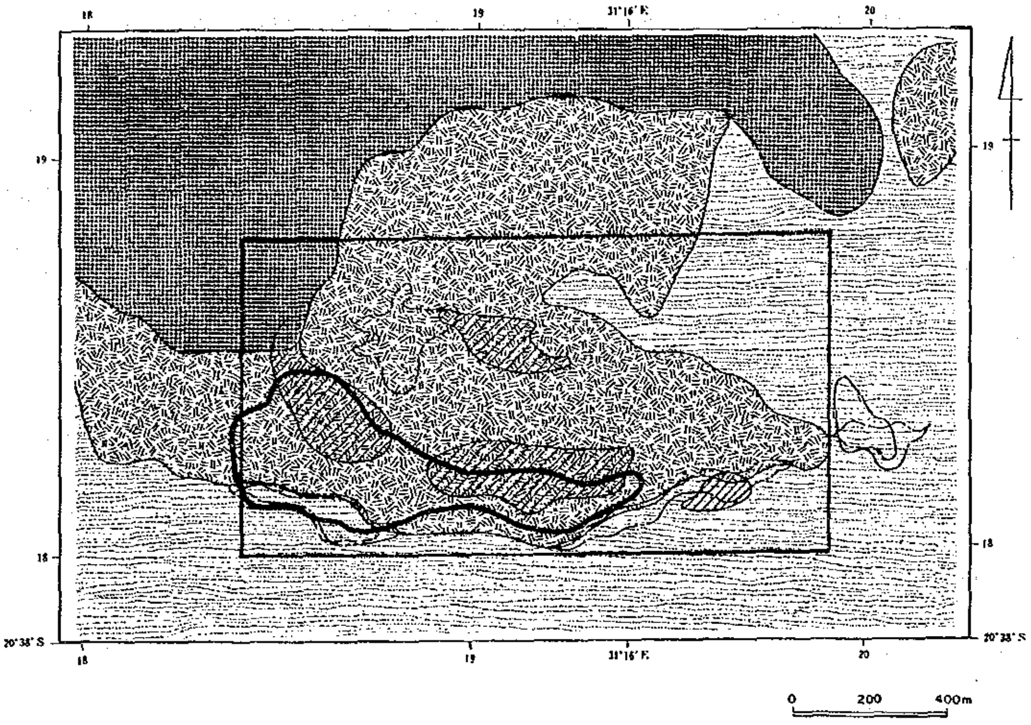


FIG. G-3(1) Summary Map of Survey Results

BENZI ZONE



FUMURE ZONE



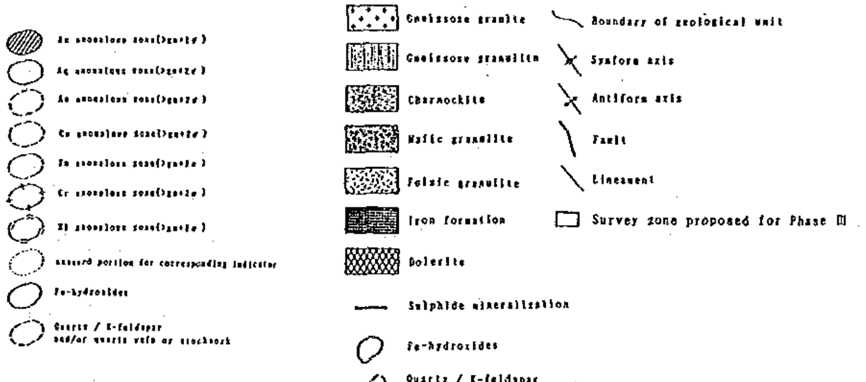


FIG. G-3(2) Summary Map of Survey Results

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PART I GENERAL REMARKS

PART I GENERAL REMARKS

CHAPTER 1 INTRODUCTION

1-1 HISTORY AND PURPOSE OF THE SURVEY

The Mineral Exploration Programme in the Macdougall Area, Zimbabwe started in September 1989, is supposed to conduct for three years with cooperation of the Geological Survey Department of Zimbabwe.

This report is the summary of survey results in the second year and will form a part of a final report.

The purpose of this survey is to delineate the area of mineral ore potential through interpretation of geological and soil geochemical survey.

1-2 CONCLUSION AND RECOMMENDATION OF PHASE I

1-2-1 Conclusion of Phase I

In the phase I programme, Landsat image interpretation, geological survey, and geochemical survey in the Macdougall area were conducted to select favourable zones for the exploration of ore deposits.

Conclusions are as follows:

Landsat Image Interpretation : CCT(Computer Compatible Tape) used this interpretation is the data of Landsat TM(Thematic Mapper). Using the data, the following GEOPIC equivalent image was produced.

(1) False-colour image full-scene, 1:250,000
(2) False-colour image sub-scene, 1:100,000
(3) Ratio image sub-scene, 1:100,000
(4) Black & white image full-scene, 1:500,000
(5) Black & white ratio image full-scene, 1:200,000
(6) Principal component image sub-scene, 1:100,000

An effort was concentrated into the determination of geological units and structure, and also detection of hydrothermally altered zones.
An interpretation of geological units and structure through Landsat image was conducted chiefly based on the differences of susceptibility to weathering, tones, vegetation patterns, drainage pattern and its density. As a results of the interpretation, the following 6 rock units were detected:

Unit: Pg (Paragneisses)
Unit: Gf (Gneissose granulite and felsic granulite)
Unit: Mg (Mafic granulite)
Unit: If (Iron formation)
Unit: Do (Dolerite)
Unit: Gg (Gneissose granite)

The lineament shows N-S, NE-SW, NW-SE, and ENE-WSW direction, among which

the N-S direction is the most conspicuous.
When the formation of the lineaments in the survey area is considered, they are thought to have developed in the following order:

(1) ENE-WSW and NW-SE direction (formed the ENE-WSW fold axis)

(2) N-S and NE-SW direction (with dolerite intrusion)

(3) NW-SE direction

For the purpose of delineation of alteration zones in the area, spectrum measurement was conducted on rocks from the principal geological units.
Based on the results of the measurement, the following two main alteration zones are selected on the Landsat image.

(1) Fe-hydroxides, chlorite, epidote etc. having Fe in their molecular formulas.

(2) representative clay minerals such as montmorillonite, sericite, kaolinite etc..

Landsat image has the advantage of allowing reconnaissance survey to be performed in a limited period covering a large area where no data of geoscience are available, due to good consistency and uniformity in contrast to aerial photography.
Ratio image (band 3/5, 4/3, 3/1 BGR) is good for the interpretation of geological units and structure, and also false-colour image for geological structures.

<u>Geological Survey</u> : The survey area is situated in the Limpopo Mobile Belt which is an extensive east-north-east trending of high grade metamorphic rocks that lies between the Zimbabwe and Kaapvaal cratons. It is approximately 600 Km long by 300 Km wide and continues across the southern portion of Zimbabwe into Botswana.

The survey area comprises mainly high grade metamorphic rocks.
The main geological units are as follows:

Gneissose granite: This unit is distributed in the northwestern margin of the area. It retains granitic texture under the microscope. The rock forms a part of Zimbabwe Craton.

Gneissose granulite: This unit predominates in the area. The rock is characterized by clear banded structure presenting a trend N 50° -70° E in general.

Felsic granulite: This unit is included in gneissose granulite and typical l-uecocratic one. Main distribution area of the rock is in the eastern part of the area.

Mafic granulite: This unit is included in gneissose granulite and felsic granulite with a width of several hundreds to 1,000 metres. It distributes mainly in southwestern to central areas. One characteristic of the rock is the formation of red soil by weathering.

Iron formation: Only several hundreds of metre width of the rock is confirmed in the field. It comprises several centimetres wide Fe-hydroxide band in quartz matrix. By weathering, it frequently exhibits a red surface appearance.

Dolerite: This is dyke rock intruding in predominantly N-S trend, however, some exhibits the same trend with WSW-ENE foliations.

The geological structure of the survey area is characterized by the ENE-WSW (N60-70E) system foliations. Although most of the foliatiations dip toward the south, there are also foliations dipping toward the north in the southern area. The whole area shows a heavy fold. It is highly possible that the survey area was divided into blocks by Sazaume-Makambe, Murerezi and Turwi faults, and that the third block between the Murerezi and Turwi faults, in which foliation was disturbed, rose comparatively high.

Eleven mineralized zones have been recognized in the area. Except for the zones poorly understood, others can be classified into the vein type deposits. Consequently, it is different from that of Renco Deposit which is a synsedimentary exhalative deposit.

Almost all assay results of samples from the mineralized zones are not so attractive from an economical point of view.

Since a mineralization zone is frequently formed by ascending ore solution through fractures, the relation between these mineralization zones and the geological structure was examined. However, no particular relationship to the main faults or lineaments was found, except that the area of low mylonitization (at the center of the southeast part in the survey area) has fewer mineralization zones and anomalous geochemical zones.

Among these mineralized zones, the following zones were determined to be promising in view of the Au grade and the elements generally found with Au mineralization (e.g. Ag,As and Bi):

(1) Jegede mineralized zone
(2) Juwere mineralized zone
(3) Muchacha mineralized zone

Geochemical similarities in some elements(e.g. : Au, Ag, As, Bi) can be pointed out between these three mineralized zones and Renco Deposit.

Geochemical Exploration : Some 2,305 stream sediments and 150 panned samples were collected from the survey area which was 2,300 km^2 wide. Analysis was carried out for Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni and Fe, and the results were used in single variate analysis and multivariate analysis. The results of these analyses were used to understand the geochemical characteristics of each geological unit.

Except for Au , the content of other elements was very low in the mineralized zones in the survey area. Geochemical anomalous zones for these were found only sporadically in comparison with those for Au, and the correlation coefficients among indicators was rather weak; consequently, no promising anomalous zones were identified.

On the other hand, 13 Au anomalous zones were detected as concentrations of anomalous geochemical values.
On the basis of the following criteria, finally seven promising Au anomalous zones have been selected.

Criteria:

(1)Number(B) of Au anomalous value which is included in an anomalous zone counts 2 points as a score.

(2)Number(C) of anomalous values of elements(Ag, As, Bi) which are included in an anomalous zone counts 1 point as a score.

(3)Number(C) of anomalous values of principal component score which are geochemically correlated to Au mineralization counts 1 point as a score.

(4)Calculation of "Index of geochemical anomaly"

"Index of geochemical anomaly"= [(B)+(C)] / (A)

Where, (A) stands for the dimension(k㎡) of the anomalous zone.

The selected calculation results of "Index of geochemical anomaly" are listed below:

ANOMALOUS ZONE	DIMENSION OF A. Z. (A)	SCORE COUNTED BY Au ANOMALY (B)	SCORE COUNTED BY OTHER A. (C)	" INDEX OF GEOCHEMICAL ANOMALY" [(B)+(C)] / (A)
① I Au ANOMALY	65 k㎡	38	8	0.71
② IV Au ANOMALY	32 k㎡	12	10	0.69
③ V Au ANOMALY	14 k㎡	12	4	1.14
④ VI Au ANOMALY	90 k㎡	44	27	0.79
⑤ VII Au ANOMALY	15 k㎡	10	6	1.07
⑥ VIII Au ANOMALY	12 k㎡	14	5	1.58
⑦ XI Au ANOMALY	28 k㎡	14	15	1.04

A. Z. : ANOMALOUS ZONE A. : ANOMALY

Seven Au anomalous zones were selected.
The results can be divided into 3 groups depending acquired scores:

ANOMALOUS ZONE	"INDEX OF GEOCHEMICAL ANOMALY" VALUE
GROUP 1	
Ⅷ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.58
GROUP 2	
V Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.14
Ⅶ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.07
X I Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.04
GROUP 3	
Ⅵ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.79
I Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.71
Ⅳ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.69

Taking all related factors, especially mineralized zones included, into consideration, the seven anomalous zones were evaluated for priority.
The results are as follows:

ANOMALOUS ZONE	"INDEX OF GEOCHEMICAL ANOMALY" VALUE	PRIORITY
Ⅷ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.58	A
V Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.14	B
Ⅵ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.79	B
Ⅶ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.07	B
X I Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.04	B
I Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.71	C
Ⅳ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.69	C

3 priority

Because of no definite discovery of mineralized zones, we calculated an "index of geochemical anomaly" as an expedient.

1-2-2 Recommendation of Phase Ⅱ

Based on the results and conclusions of the Phase I programme, the following surveys are recommended for the Phase Ⅱ programme.
Exploration targets for Phase Ⅱ are the selected 7 anomalous zones.

ANOMALOUS ZONE	PRIORITY
Ⅷ Au ANOMALY	A
V Au ANOMALY	B
Ⅵ Au ANOMALY	B
Ⅶ Au ANOMALY	B
X I Au ANOMALY	B
I Au ANOMALY	C
Ⅳ Au ANOMALY	C

Detailed geological survey and geochemical survey by soil should also be conducted.

Geological survey : A detailed geological mapping within the geochemical anomalous zones and mineralized zones is recommended. After the interpretation of the survey results, target areas for geochemical survey by soil should be selected.

Geochemical survey : Geochemical survey consists of soil geochemistry. Indicators applied are Au, Ag, As, Bi, Cu, F, Cr, Ni, Fe as well as the Phase 1 programme. Systematic line cutting and some trenches should be conducted.

1-3 OUTLINE OF PHASE II

1-3-1 Survey Area

The survey area lies within the catchment area of the Savi river which is located in the south-eastern part of the Republic of Zimbabwe. The mileage and time required by vehicle from Harare to the survey area are roughly as followed;

(1) Harare to Beatrice : 50 Km / 0.7 hour
(2) Beatrice to Chivhu : 80 Km / 1.0 hour
(3) Chivhu to Gutu : 80 Km / 1.0 hour
(4) Gutu to Zaka : 90 Km / 1.3 hour
(5) Zaka to Chiredzi : 90 Km / 1.3 hour

The area is served by the main tar road from Harare, branching off the Masvingo through Zaka to Chiredzi. This road traverses the survey area and good quality gravel road and tracks of variable condition serve as survey routes. Major parts of the area are accessible to a 4-wheel drive vehicle during the dry season

1-3-2 Purpose of Survey

The survey was planned to be carried out over three years, starting at the beginning of last year, 1989. Since the geological features of the MaCdougall area which is to be surveyed, are similar to those of the Renco Deposit, the possibility of finding a similar deposit in the area is thought to be high. This fiscal year, geological survey, and soil geochemical survey were carried out to evaluate the feasibility of finding a deposit in the areas selected by the results of phase I survey.

1-3-3 Method of Survey

The survey area, 500 km^2, is included in the area having the base points being at longitude 31° 15' west and latitude 20° 30' south in the southwest edge, and at longitude 32° 00' west and latitude 20° 15' south in the northeast edge. Lake MaCdougall is nearly at the center of the survey area.

This fiscal year, geological and soil geochemical surveys were carried out.

In the geological survey, efforts were made to clarify the geology and the extent of mineralization of the survey area to indicate promising deposits, making use of the results of the Phase I. For the field survey, a topographical map in scale of 1:50,000, was enlarged to a scale of 1:25,000 and used as a route map. The survey route was determined by examining the results of the Landsat image analysis and taking the geological structure of the survey area into consideration. Aerial photographs and magnetic susceptibility meters were used in the survey. Sampling was performed carefully to identify rocks and rock facies typical to each survey location, and the interrelation between them. Thin section samples were collected from each species of rock or each type of rock with different rock facies, in the case where a species showed various rock facies, so that a microscopic examination could be carried out. In addition, sampling for x-ray diffraction was performed as necessary. Samples of ores and mineralized rocks were collected for polishing, examination, and chemical analysis. The overall length of the survey route was 500 km, covering the whole survey area.

In the geochemical survey, soil samples were collected according to a pre-laid grid(at 30-meter interval and 100-meter spaced line) measured by tape and transit after careful study of sampling conditions. Duplicated sampling were taken at several points. Fraction of -80 mesh were taken and analyzed on the elements of Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni and Fe. B-horizon samples are preferred, since they are often the sample media of metal accumulation. Samples of 50 g or more were kept for each soils which had been chemically analyzed so that it could be used in re-analysis.

The area subjected to the survey is selected as the promising area for the potential of mineral ore existence.

The outline of this year's survey is as follows:

TABLE 1-1-1 OUTLINE OF SURVEY

SURVEY METHOD	EXTENT	CONTENTS
GEOLOGICAL SURVEY	500 Km^2	500 Km SURVEY ROUTE LINE
GEOCHEMICAL SURVEY	(9 ZONES)	10,047 SOIL SAMPLES

KIND OF TESTS	NO. OF SAMPLES	REMARKS
①MICROSCOPIC OBSERVATION OF ROCK THIN SECTIONS	50	
②MICROSCOPIC OBSERVATION OF ORE POLISHED SECTIONS	30	
③MICROSCOPIC OBSERVATION OF POLISHED-THIN SECTIONS	10	
CHEMICAL ANALYSIS ④ROCKS	50	SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, LOI, Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni
⑤ORES	30	Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni, Fe
⑥SOIL SAMPLES	10,047	Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni, Fe
⑦HOMOGENIZATION TEMPERATURE MEASUREMENT	20	
⑧X-RAY DIFFRACTION TEST	20	
⑨EPMA ANALYSIS	10	
⑩MODAL ANALYSIS	10	

1-3-3 Member of Survey Team

The members involved in the planning, managing and field survey are as follows:

Planning and Managing

JAPANESE MEMBER		ZIMBABWE MEMBER	
TAKAHISA YAMAMOTO	M M A J	JOHN L. ORPEN	G S D
HIROSHI SHIMOTORI	M M A J	N. BAGLOW	G S D

Field Survey

JAPANESE MEMBER		ZIMBABWE MEMBER	
FUMIO WADA	D O W A	TAFIRENYIKA CHIYANIKE	G S D
TSUTOMU KODAMA	D O W A		
SHINICHI IWAYA	D O W A		

1-3-4 Period of Survey

Schedule of the survey is as follows:

①GENERAL SCHEDULE

SURVEY ITEMS	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.
PLANNING & OREPARATION	— 8							
FIELD SURVEY	9 —	—	—	— 10				
ANALYSIS & INTERPRETATION		1 —	—	—	—	—	— 31	
REPORTING						1 —	—	— 18

②SCHEDULE OF FIELD SURVEY

SURVEY ITEMS	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.
JAPAN TO HARARE	9 — 10							
DISCUSSION	11							
HARARE TO CHIREDZI	12							
PREPARATION	13 — 14							
GEOLOGICAL SURVEY	15 —	— 14						
GEOCHEMICAL SURVEY		15 —	—	— 3				
CHIREDZI TO HARARE				4				
INTERPRETATION & REPORTING		1 —	—	— 3				
REPORT ON SURVEY RESULTS				5 — 6				
HARARE TO JAPAN				7 — 10				

CHAPTER 2 GEOGRAPHY OF THE SURVEY AREA

2-1 TOPOGRAPHY AND DRAINAGE

The topography in the area is characterized by the gentle undulation of peneplain due to the bedrock geology of Archaean rocks.

The area, lying about 600 m, covers the junction between the lowvelt and highvelt country. The highest peak in the area is Demba Mountain (1,059 m) and other prominent peaks are Babaninga M.(1,037 m) and Muromahoto M.(1,001 m) both lying in the northern part of the area. The alignment of the mountains and hills are strongly influenced by the geological structure prevailing on the area.

The main drainages in the area are Mashavutwe River, Chiredzi R., and Turwi R., and flow down to the Savi River. Although the most drainages dry up in the dry season, these 3 rivers are fed by water all around the year.

2-2 CLIMATE AND VEGETATION

The climate of the area is clearly divided into two seasons a dry season from April to October and a wet season from November to March.

The temperature in October rises to more than 40° c due to the low altitude of some 600 m and low latitude of 20° s.

Annual rainfall average of 700 mm and 600 mm have been recorded at Zaka and Baffalo Range to the north and south of the survey area, respectively. Almost all rainfall concentrate into the wet season, especially December to February. There is only a temporary run-off during wet season.

Vegetation in the area consists mainly of mopane and mangwe with a few baobao, acacias, and palms. The ranches well-managed are generally well-grassed, but the area of over-grazing has caused depletion of vegetation. Although the large scale sugar cane cultivation prevails in the lowvelt country south to the survey area, the agriculture within the survey area is limited into small scale.

CHAPTER 3 GENERAL GEOLOGY

3-1 GENERAL GEOLOGY

The Limpopo Mobile Belt is an extensive east-north-east trending of high grade metamorphic rocks that lies between the Zimbabwe and Kaapvaal cratons. It is approximately 600 km long by 300 km wide and continues across the southern portion of Zimbabwe into Botswana.

The belt may be subdivided into three zones, that is, northern and southern marginal zones and a central zone. The northern marginal zone is further subdivided into a granulite subzone, characterized by metamorphism of granulite facies and a a zone suffered intense shear deformation and retrograde metamorphism.

In regard to geological structure, the predominant feature throughout the Northern Marginal Zone is a persistent east-north-easterly foliation. Isoclinal folding is strongly suggested due to constant south dipping of the foliation.

But the rock units in the area are complexly folded and refolded on all scale.

Measurements of foliation have been made of the orientation of the mineral banding in the granulite. These data are presented in stereographic projections. No significant differences of foliation pattern are recognized in either the southwestern or northeastern area. The poles have been interpreted as the predominant fold axis.

In the central part of the area, the mafic granulite forms flow folding which is revealed by Landsat image and the mapping. This type of folding is recognizable throughout the area on a small scale in individual outcrops.

3-2 GEOLOGICAL BACKGROUND OF THE SURVEY AREA

The Northern Marginal Zone of the Limpopo Mobile Belt comprises high grade metamorphic rocks. No formal lithologic or stratigraphic subdivision of the rocks has been made. The emplacement ages of the rocks in the Northern Marginal Zone are uncertain but are probably more than about 2,870 Ma(Barton, 1983; Hickman, 1978). Metamorphic conditions in the Northern Marginal Zone are thought to have been greater than 750 ℃ and 5 kilobars at about 2,870 Ma ago(Robertson and Du Toit, 1981). It is thought that this metamorphic event was strong enough to eliminate any possible previous metamorphic evidents. A second metamorphism may have occurred about 2,700 Ma ago. This is roughly coeval with the last metamorphism in the Southern Marginal Zone.

Also this belt has been affected by deformations. On the this topic, agreement has not been reached among researchers. In the Northern Marginal Zone, at least two regional deformational events are recognized(Robertson and Du Toit, 1981)but the age of these deformations is uncertain.

Occurrences of mineralization in the Northern Marginal Zone are quite limited. Economic mineralization of chromite within a serpentinite complex and highly folded gold mineralization in enderbites at Renco deposit are the principal ones. Exploration for Cu-Ni mineralization has been largely unsuccessful although small deposits associated with mafic granulite are found.

CHAPTER 4 DISCUSSION ON THE SURVEY RESULTS

4-1 RELATION BETWEEN GEOLOGICAL STRUCTURE AND MINERALIZATION

In general, geological units distributed in the survey area have foliations stretching in the ENE-WSW direction, and the geological structure is characteristically regulated by the foliations of geological units. The foliations are especially remarkable in felsic granulite and gneissose granulite. In the survey area, there are also a number of smaller tectonic lines associated with displacement and other lineaments which can be extracted from satellite images or aerial photographies, in addition to the Sazaume-Makambe tectonic line, the Vurumuku tectonic line, the Murerezi tectonic line and other larger tectonic lines.

No universal relationship could be found between these tectonic lines and mineralized zones found in the survey area.

However, when collectively evaluating the conditions of mineralization found in the survey area, i.e. mineralized zones of Juwere, Jegede and Muchacha and other zones with mineralized signs, the following relationships were noted between geological structure and mineralization: The Juwere zone crosses in a gentle with foliations stretching in the ENE-WSW direction. These are common in the survey area, while, in general, the Jegede zone and Muchacha zone exist conformably with the foliations, suggesting the possibility that mineralization occurred prior to metamorphism. This hypothesis is supported by the fact that the fluid inclusions have reduced particle sizes by metamorphism of the original fluid inclusion, and by microscopic observation of polished sections showing that the configuration of sulphide minerals is parallel to the foliations.

Results of analysis and general geological properties of typical mineralized zones in the survey area are summarized as follows:

MINERALIZED ZONE	MINERALIZED METAL	GEOLOGY	MINERALIZED SIGNS
NE-MANHANZVA	----------	Felsic Granulite Charnockite	pegmatite quartz & K-feldspar
JUWERE	Au-Bi?-Cu-Cr-Ni?	Gneissose granulite Mafic Granulite	sulphides & Fe-hydroxides
JEGEDE	Au-As-Bi?-Cu?-Zn?-Cr??	Mafic Granulite	sulphides & Fe-hydroxides
MUCHACHA	Au-As-Bi?-Zn-Ni?	Mafic Granulite	sulphides &

			Fe-hydroxides
CHAMBURUKIRA	----------	Felsic Granulite Gneissose Granulite	pegmatite quartz & K-feldspar
BENZI	Au-As-Bi?-Zn	Gneissose granulite Mafic Granulite	Fe-hydroxides quartz vein/stockwork pegmatite quartz & K-feldspar
RUPIRI	Au-As-Ni	Gneissose granulite Mafic Granulite	Fe-hydroxides (quartz vein/stockwork)
E-CHIPFUTI SCHOOL	----------	Felsic Granulite Gneissose Granulite	pegmatite quartz & K-feldspar
Faversham I&II	--------	Gneissose granulite Charnockite	pegmatite quartz & K-feldspar
FUMURE	As-Cr-Ni?	Mafic Granulite	sulphides & Fe-hydroxides
NYAHONDO	As-Cu-Cr	Gneissose Granulite	pegmatite quartz & K-feldspar (Fe-hydroxides)
CHIPFUNDE	As-Cu-Ni	Mafic Granulite Gneissose Granulite	Fe-hydroxides (quartz vein/stockwork)
MUSHAYA	----------	Charnockite Gneissose Granulite	pegmatite quartz & K-feldspar (&/or quartz vein/stockwork)

The question remains whether the samples obtained from these zones accurately reflect their original metal content, considering the poor outcrop conditions of these zones. This question arose because the metal content of the samples are frequently lower than the corresponding indicator elements in the soil.

As for control of mineralization observed in the field, affinity with mafic granulite is noticeable in the Juwere zone, the Jegede zone and the Muchacha zone. In other zones, the same tendency of Au characteristically appears as the following conditions of code 3 :

(1)high geometrical mean

(2)relatively high contrast values against mafic granulite forming the background area

(3) correlation with principal component of lower order.

When classifying by mineralization in the surveyed area on the basis of the type of sulphide mineral, pyrite, pyrrhotite, chalcopyrite and marcasite are commonly distributed in the Juwere, jegede and Muchacha mineralized zones. This indicates a rather monotonous combination of minerals.

Mineralized zone in the area has not been cleared the relation to geological structure. Some kind of mineralization, however, are restricted their occurrence into the certain rock units.

4-2 MINERAL POTENTIAL ON THE SURVEY AREA

Au deposits are expected in the surveyed area. However, results of analysis on samples from mineralized zones generally indicate low content of Au and other metals partly because the samples may have been subjected to leaching.

Results of geochemical soil exploration are summarized below.

SURVEYED ZONE	ROCK CODE	Au VALUE(PPB) GM+σ	GM+2σ	MAXIMUM	CONTRAST (GM+σ)	RELATED P. C.	DIMENSION OF ANOMALY (>GM+σ : M x M)
	R.C.3	1.86	4.12	8.00	3.71	P.C.3	100 x 800
JUWERE	R.C.4	1.44	2.78	6.00	2.87	P.C.4	
	R.C.5	1.48	3.01	115.00	1.00	P.C.4	
	R.C.3	5.74	20.04	954.00	11.49	P.C.2	200 x 2400
JEGEDE	R.C.4	2.83	8.20	76.00	1.41	P.C.4	
	R.C.5	2.54	6.97	1490.00	5.07	P.C.4	
	R.C.3	4.74	14.98	23.00	9.47	P.C.2	200 x 500
MUCHACHA	R.C.4	1.38	2.76	7.00	2.83	P.C.3	
	R.C.5	1.42	2.80	27.00	2.84	P.C.5	
	R.C.3	----	----	----	----	-----	100 x 400
CHAMBURUKIR	R.C.4	2.98	5.31	6.00	4.53	P.C.3	
	R.C.5	1.89	4.12	8.00	1.34	P.C.5	
	R.C.3	22.73	159.74	922.00	45.46	P.C.1	200 x 2000
BENZI	R.C.4	8.56	36.75	753.00	17.13	P.C.4	
	R.C.5	9.44	43.25	848.00	14.98	P.C.4	
	R.C.3	2.16	4.92	6.00	----	P.C.4	100 x 800
RUPIRI	R.C.4	----	----	----	----	-----	
	R.C.5	2.05	4.66	10.00	4.10	P.C.3	
	R.C.3	12.61	54.99	221.00	25.21	P.C.2	200 x 1000
FUMURE	R.C.4	----	----	----	----	-----	
	R.C.5	2.03	4.52	8.00	4.06	P.C.4	
	R.C.3	----	----	----	----	-----	100 x 500
NYAHONDO	R.C.4	----	----	----	----	-----	
	R.C.5	2.14	4.33	133.00	1.17	P.C.5	
	R.C.3	5.77	19.47	83.00	5.77	P.C.4	100 x 1000
CHIPFUNDE	R.C.4	----	----	----	----	-----	
	R.C.5	2.60	6.76	115.00	3.67	P.C.4	

------ : NO DATA

From the above table, when giving attention to:
① Au content, ② contrast and ③ extension of anomalous zone, potential of existence of Au mineralization is high in:

(1) Jegede zone

(2) Benzi zone and

(3) Fumure zone.

Although the signs of anomalies found by geochemical soil exploration are weaker, we will recommend the mineralized zones of Juwere and Muchacha as next most promising zones, because of the possibility that the above results may reflect sampling from leached zones.

4-3 RELATION BETWEEN GEOLOGICAL ANOMALIES AND MINERALIZATION

Relationship between anomalies found by geochemical exploration and mineralization in the survey area is summarized in Table 1-4-1.
As shown in the table, analytical results of samples from mineralized zones and corresponding soil samples did not indicate good relationship in terms of Au, except for the Jegede and Benzi mineralized zones.
As for the Benzi mineralized zone, high contrasts were obtained for every rock code, suggesting that concentration of Au occurred over multiple geological units. On the whole, zones with high mineralization potential, where sulphides or Fe-hydroxides are distributed, tend to have anomalies determined by geochemical exploration.
In such zones, anomalies have:

(1) relatively high Au content

(2) good continuity.

On the other hand, ①Jegede zone, ②Benzi zone, and ③Fumure zone have well noted Au geochemical anomalies. They can concluded to be possibly a kind of hydromorphic anomalies judging from their mode of occurrence, that is, their anomalous localities are preferentially on the topographic depression.

A possible transportation of Au can explain by the following chemical equations(Cloke & kelly, 1964).

$$3H_2O + Au^0 = H_2AuO_3^- + 4H^+ + 3e^-$$

$$4Cl^- + Au^0 = AuCl_4^- + 3e^-$$

$$Au^0 = Au^{+++} + 3e^-$$

These equations depends on one or two of Eh, pH, and Cl^-. The results of experiments by the authors also support the relative high mobility of Au under the natural environment. Krauskopf(1951) and Mann(1984) also suggest that Au has relatively high mobility under the certain environment.

TABLE 1-4-1 Summary of Mineralized Zone

MINERALIZED ZONE	MINERALIZED METAL IN ORE	GEOLOGY	MINERALIZED SIGNS	HIGH CONTRAST INDICATOR IN SOIL R.C.3	R.C.4	R.C.5	CHARACTERISTICS OF Au GEOCHEMICAL ANOMALY
JUWERE	Au-Bi?-Cu-Cr-Ni?	Gneissose granulite Mafic Granulite	sulphides & Fe-hydroxides	-------	-------	-------	low content, poor continuation
JEGEDE	Au-As-Bi?-Cu?-Zn?-Cr??	Mafic Granulite	sulphides & Fe-hydroxides	Au, As	Ag, Cu, Cr	Cr	high content, well continuation, hydromorphic anomaly?
MUCHACHA	Au-As-Bi?-Zn-Ni?	Mafic Granulite	sulphides & Fe-hydroxides	As	Cr	Cr	rather high content, poor continuation
CHAMBURUKIRA		Felsic Granulite Gneissose Granulite	pegmatite quartz & K-feldspar		Cr	-------	low content, poor continuation
BENZI	Au-As-Bi?-Zn	Gneissose granulite Mafic Granulite	Fe-hydroxides quartz vein/stockwork pegmatite quartz & K-feldspar	Au	Au, Fe	Au	high content, well continuation, hydromorphic anomaly??
RUPIRI	Au-As-Ni	Gneissose granulite Mafic Granulite	Fe-hydroxides (quartz vein/stockwork)			-------	low content, rather poor continuation
FUMURE	As-Cr-Ni?	Mafic Granulite	sulphides & Fe-hydroxides	Au, As, Cu		Cr, Ni	high content, well continuation, hydromorphic anomaly?
NYAHONDO	As-Cu-Cr	Gneissose Granulite	pegmatite quartz & K-feldspar (Fe-hydroxides)			-------	low content, poor continuation
CHIPFUNDE	As-Cu-Ni	Mafic Granulite Gneissose Granulite	Fe-hydroxides (quartz vein/stockwork)	-------		-------	low content, rather poor continuation

BLANK : NO DATA
----- : LOW CONTRAST

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5-1 CONCLUSION

This year, the second year of the cooperative mineral exploration in the Republic of Zimbabwe, a geological survey and geochemical survey were carried out. A summary of the survey is described below.

Geological Survey: The survey area is located in the Northern Marginal Zone (NMZ) of the Limpopo Mobile Belt, which stretches from ENE to WSW, dividing Zimbabwe Craton from Kaapvaal Craton. The NMZ is 30 to 40 km wide at the section which is in contact with Zimbabwe Craton. The area consists of the following geological units:

(1) Gneissose granulite : (high metamorphic rock)
(2) Felsic granulite : (high metamorphic rock)
(3) Mafic granulite : (high metamorphic rock)

Iron information and dolerite are also observed.

The geological structure of the survey area is characterized by the foliation of the ENE-WSW (N60-70E) system. Foliation is generally considered as a south dip, but in the south of the survey area, north dip foliation is also observed showing a highly folded form. The survey area is divided into four main blocks according to principal tectonic lines (Zazaume-Makambe tectonic line, Vurumuku tectonic line, and Murerezi tectonic line), and these blocks are thought to be subjected to ascending and descending block movements.

From the first year's survey, respective areas estimated as promising Au zones were selected as described below.

REASON FOR SELECTION	NUMBER OF AREA	EXTENT(km^2)
ANOMALOUS AREA INDICATED BY MULTIPLE SAMPLES	10	349
ANOMALOUS AREA INDICATED BY SINGLE SAMPLE	2	137
ANOMALOUS AREA INDICATED BY PANNED SAMPLE	7	14
TOTAL	10	500

Nine zones shown in the following table were selected after semi-detailed geochemical survey from these areas, noting the conditions of mineralized signs (sulphides, Fe-hydroxides, quartz vein/stockwork, pegmatite quartz and K-feldspar).

There is poor relation of indicator contents between the samples from mineralized zones (Juwere mineralized zone, Jegede mineralized zone, Muchacha mineralized zone, etc.) accompanied by sulphides confirmed by this semi-detailed geological survey, and the contents of the indicators from the surrounding soil samples. It was found that anomalous values in the soil samples are apt to contain a higher Au content than values in the samples from the mineralized zones. It may suggests that the mineralized zones have been subjected to weathering.

Geochemical Survey : Soil samples (B-horizon) of 10,047 were collected from the nine zones of the following table selected by the geological survey, and analyses related to Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni and Fe were carried out.

ZONE	BASE LINE(M)	SAMPLING LINE(M)	SOILS
JUWERE	1,500	2,970	1,560
JEGEDE	2,500	1,470	1,277
MUCHACHA	2,500	1,020	907
BENZI	2,000	1,020	728
RUPIRI	3,800	1,470	1,593
CHIPFUNDE	3,200	1,200	898
FUMURE	2,000	1,260	696
NYAHONDO	2,200	1,680	1,057
CHAMBURUKIRA	1,900	2,190	1,331
TOTAL			10,047

By considering the direction in which mineralized signs and a principally related geologic units thought to be associated with mineralization extend, the directions of the soil collection lines, except for the Juwere zone (Juwere mineralized zone is observed as roughly N-S system), were set at a direction of N-S system because in the zone's geological structures an ENE-WSW system prevails.

The analytical results of collected soil samples were interpreted by single variate analysis and multivariate analysis so that the geochemical characteristics of the geological units from which the samples originated could be determined.

From the results, the following three zones

(1) Jegede zone

(2) Benzi Zone

(3) Fumure Zone

can be judged as promising because of

(1) the stable and continuous distribution,

(2) high Au value

(3) clear contrast

etc. in the geochemical anomalous zones regarding Au in each zone. On the other hand, the following two zones are proposed as targets of IP survey to confirm for their continuation of sulphide mineralization.

(4) Juwere Zone

(5) Muchacha Zone

Ag contents, and other elements in the mineralized zones in the surveyed zones, were generally low and limited extent. The appearance of geochemical anomalous zones was more scattered than that of Au, and a correlation among indicators was poor, so that no promising anomalous zones of Ag and other elements were found.

The measurements of homogenization temperature using fluid inclusions in quartz suggest that temperature of sulphide mineralization in the area;

220 ~ 300 ℃.

The fact indicate the mineralization will be classified into the category of epithermal deposit by formation temperature.

An attempt was conducted to estimate the metamorphic conditions by applying the geothermometer and geobarometer. The results are as follows;

Temperature 540 ~ 740 ℃.

Pressure 1.4 ~ 5.8 KB.

The results probably show retrogressive metamorphic episodes rather than peak metamorphism in the area.

5-2 RECOMMENDATION

On the basis of the second year's survey results, and from the conclusions obtained through discussing the results, we propose to conduct the following survey in the third year.

Subject zones to be surveyed are the following zones with promising geochemical anomalies and mineralized signs:

(1) Jegede anomalous zone

(2) Benzi anomalous zone

(3) Fumure anomalous zone

(4) Juwere mineralized zone

(5) Muchacha mineralized zone

Methods of survey to be applied are:

(1) Geophysical exploration (IP method)

(2) Drilling exploration

The outline of the survey is as follows:

Geophysical Exploration (IP Method): This exploration will be performed to confirm the existence of mineralized zones in and around anomalous zones by detecting sulphide minerals. The exploration is recommended to be conducted in both geochemical anomalous and mineralized zones to the depth of 300m.

Drilling Exploration: Drilling exploration is conducted to confirm the deeper extension of the mineralized zones found by geological surveys, and to check the results of geophysical exploration (IP method) which are conducted on geochemical anomalies obtained by soil geochemical survey. Drilling exploration is conducted to determine mineralized zones from the existence of continuity and mineralization conditions, from the surface to a depth of 150m, while geophysical exploration is performed to a depth of 300m.

Planning of the IP survey must be considered the possibility of hydromorphic anomalies of the following three anomalous zones:

(1) Jegede zone

(2) Benzi zone

(3) Fumure zone.

On the IP surveys in two mineralized zones, that is,

(4) Juwere zone and

(5) Muchacha zone

the prime emphasis will put on the confirmation of mineralized zone for the direction of depth and lateral continuation. Rather small work will be needed to confirm it.

PART II DETAILS OF THE SURVEY

PART II DETAILS OF THE SURVEY

CHAPTER 1 GEOLOGICAL SURVEY

This report comprehensively considers the relationship between geological structures and mineralization in the survey areas.

Survey areas chosen based on Phase I results are as follows:

SYMBOL	SURVEY AREA	TYPE OF GEOCHEMICAL ANOMALY	EXTENT (km^2)
A-1	ANGUS	G. A. BY MULTIPLE S. S.	40
A-2	CHIREZANA	G. A. BY MULTIPLE S. S.	105
A-3	BENZI	G. A. BY MULTIPLE S. S.	30
A-4	MANJIRENJI WEST	G. A. BY MULTIPLE S. S.	10
A-5	RUPIRI	G. A. BY MULTIPLE S. S.	20
A-6	CHEMHONDORO	G. A. BY MULTIPLE S. S.	40
A-7	FAVERSHAM	G. A. BY MULTIPLE S. S.	36
A-8	FUMURE	G. A. BY MULTIPLE S. S.	40
A-9	NYAHONDO	G. A. BY MULTIPLE S. S.	10
A-10	BANGALA	G. A. BY MULTIPLE S. S.	18
B-1	MACDOUGALL-SE	G. A. BY SINGLE S. S.	2
B-2	MACDOUGALL-N	G. A. BY SINGLE S. S.	2
B-3	SVUWURE-SE	G. A. BY SINGLE S. S.	2
B-4	SVUWURE-NW	G. A. BY SINGLE S. S.	2
B-5	DABWA-SE	G. A. BY SINGLE S. S.	2
B-6	CHIVAMBA-E	G. A. BY SINGLE S. S.	2
B-7	CHIBAMVA-S	G. A. BY SINGLE S. S.	2
C-1	CHIPFUNDE	G. A. BY PANNED S. S.	120
C-2	MUSHAYA	G. A. BY PANNED S. S.	17

G. A. BY MULTIPLE S. S. : GEOCHEMICAL ANOMALIES BY MULTIPLE STREAM SEDIMENTS
G. A. BY SINGLE S. S. : GEOCHEMICAL ANOMALIES BY SINGLE STREAM SEDIMENT
G. A. BY PANNED S. S. : GEOCHEMICAL ANOMALIES BY PANNED STREAM SEDIMENTS

TABLE 2 - 1 - 1 List of Mineralized Zone

MINERALIZED ZONE	MINERALIZED METAL	GEOLOGY	MINERALIZED SIGNS
NE-MANHANZVA	----------	Felsic Granulite Charnockite	pegmatite quartz & K-feldspar
JUWERE	Au-Bi?-Cu-Cr-Ni?	Gneissose granulite Mafic Granulite	sulphides & Fe-hydroxides
JEGEDE	Au-As-Bi?-Cu?-Zn?-Cr??	Mafic Granulite	sulphides & Fe-hydroxides
MUCHACHA	Au-As-Bi?-Zn-Ni?	Mafic Granulite	sulphides & Fe-hydroxides
CHAMBURUKIRA	----------	Felsic Granulite Gneissose Granulite	pegmatite quartz & K-feldspar
BENZI	Au-As-Bi?-Zn	Gneissose granulite Mafic Granulite	Fe-hydroxides quartz vein/stockwork pegmatite quartz & K-feldspar
RUPIRI	Au-As-Ni	Gneissose granulite Mafic Granulite	Fe-hydroxides (quartz vein/stockwork)
E-CHIPFUTI SCHOOL	----------	Felsic Granulite Gneissose Granulite	pegmatite quartz & K-feldspar
Faversham I&II	--------	Gneissose granulite Charnockite	pegmatite quartz & K-feldspar
FUMURE	As-Cr-Ni?	Mafic Granulite	sulphides & Fe-hydroxides
NYAHONDO	As-Cu-Cr	Gneissose Granulite	pegmatite quartz & K-feldspar (Fe-hydroxides)
CHIPFUNDE	As-Cu-Ni	Mafic Granulite Gneissose Granulite	Fe-hydroxides (quartz vein/stockwork)
MUSHAYA	----------	Charnockite Gneissose Granulite	pegmatite quartz & K-feldspar (&/or quartz vein/stockwork)

Selection criterion of soil geochemical surveyed areas

To select the objective zones of soil geochemical survey, first the selection criterion was set and then on the basis of the second selection criterion, the ranking of the degree of promise was decided.

The first selection criterion : The reconfirmation of existence of mineralization and geochemical anomalous values.

(1) First preference : The zones indicated by multiple anomalous values by stream sediments.

(2) Second preference : The zones indicated by anomalous value by panned sample.

(3) Third preference : The zones indicated by anomalous value by single stream sediment.

The second selection criterion: By noting the way that mineralized signs(sulphides, Fe-hydroxides, quartz vein/stockwork, pegmatite quartz & K - feldspar) stand, preferences were set as follows.

(1) Zones where mineralization was actually observed. In such zones most of the mineralized signs are observed as outcrops and/or floats.

(2) Zones where some mineralized sings were observed with some extent.

In these cases preferences were decided by considering the signs below.

1) sulphides

2) Fe-hydroxides

3) quartz vein/stockwork

4) pegmatite quartz & K-feldspar

In particular, zones where sulphides and Fe-hydroxides were observed (in of many cases quartz vein/stockwork and pegmatite quartz & K-feldspar were also observed), were highly rated as objective zones for soil geochemical survey. Zones where only quartz vein/stockwork, and pegmatite quartz & K-feldspar were observed, were ranked lower.

(3) Zones where mineralized signs were not observed, were eliminated on principle, even if anomalous values on geochemical survey were high.
This is because the degree of anomaly probably depends on the distance to the anomalous source contributing to a site where stream sediment is collected, and the presence of the anomalous source is more important in geochemical survey by stream sediments.

ABSOLUTE AGE	GEOLOGIC TIME	SYSTEM/GROUP	ROCK TYPES	GEOLOGIC COLUMN	MINERALIZATION
	PLEISTOCENE /RECENT	KALAHARI	ALLUVIUM AEOLIAN SANDS		ALLUVIAL GOLD
	CRETACEOUS~ UPPER JURASSIC		ALKALINE VOLCANICS SANDSTONE ETC		
	JURASSIC TRIASSIC PERMIAN	KAROO	RHYOLITE BASALT SANDSTONES, SILTSTONES, ETC. GLACIAL BEDS, COAL MEASURES, MUDSTONES		TUNGSTEN, COPPER
	LATE PRECAMBRIAN	SIJARIRA TENGWE RIVER MAKUTI RUSHINGA	SANDSTONES, SHALES, CONGLOMERATE, ETC. LIMESTONE, DOLOMITE & ORTHOQUARZITE PARAGNEISS, METASEDIMENTS & AMPHIBOLITE		zinc, copper, lead copper
	MID PRECAMBRIAN	MALAFUTESE & KAIIRE DOKONDO LOMAGUNDI PIRIWIRI	PARAGNEISS, METASEDIMENTS & AMPHIBOLITE LIMESTONE, SHALE, QUARTZ & BASALT QUARTZ-MICA SCHISTS, ORTHOQUARTZITE, ETC. STRIPPED SLATES & MINOR QUARTZITE DOLOMITE & ORTHOQUARTZITES META-ARKOSE & BASIC METAVOLCANICS PHYLLITE & MINOR QUARTZITES		COPPER COPPER COPPER, lead COPPER, SILVER, GOLD TIN, TUNGSTEN, COPPER GOLD, TANTALUM, manganese lead, zinc
2700 . -2600 Ma*		LIMPOPO MOBILE BELT	IRON FORMATION (If) MAFIC GRANULITE (Mg) FELSIC GRANULITE (Fg) GNEISSOSE GRANULITE (Gg)	DOLERITE 1700 Ma Gg Mg Fg Gg Fg	CHROME, GOLD, TUNGSTEN zinc
3200 Ma 3300 Ma 3500 Ma	EARLY PRECAMBRIAN	BEITBRIDGE SHAMVAIAN BULAWAYAN SEBAKWIAN	PARAGNEISSES, HIGH-GRADE SEDIMENTS & ANORTHOSITIC GNEISSES METASEDIMENTS, FELSIC METAVOLCANICS METASEDIMENTS, FELSIC METAVOLCANICS ANDESTIC & DACITIC METAVOLCANICS BASALTIC METAVOLCANICS WITH METASEDIMENTS ULTRAMAFIC LAVA & INTRUSIONS		copper, magnetite GOLD, SILVER, IRON ORE COPPER, NICKEL, LEAD, ZINC, MANGANESE, TUNGSTEN PYRITE
3600 -3500 Ma		ARCHAEAN GRANITIC ROCKS	OLDER GNEISS COMPLEX		

✱: METAMORPHIC AGE

MINERAL PRODUCED : GOLD
MINERAL NOT PRODUCED: copper

FIG. 2-1-1 Idealized Geological Column

TABLE 2-1-1 List of Mineralized Zone

	SAMPLE NO.	MINERALIZED ZONE	COORDINATION		Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe
			X	Y	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
1	A20W01	JEGEDE	59.04	23.00	30.0	1.90	1.0	0.80	2,130	90	38	286	139	4.61
2	A20W02	JEGEDE	59.10	23.18	3.0	0.25	35.0	0.30	83	67	120	27	128	5.85
3	A20W04	JEGEDE	59.10	23.18	0.5	0.25	10.0	0.20	58	10	109	288	73	4.46
4	A20W05	JUWERE	59.12	27.04	40.0	0.25	1.0	0.40	1,520	10	62	357	407	6.81
5	A20W06	JUWERE	59.12	27.04	28.0	0.25	1.0	0.30	1,410	25	44	326	240	6.29
6	A20W07	MUCHACHA	62.53	25.93	0.5	0.25	2.0	0.10	53	10	735	60	131	7.54
7	A20W08	JEGEDE	59.18	23.20	4.0	0.25	23.0	0.40	232	10	40	550	126	8.20
8	A20W10	JUWERE	58.03	27.48	72.0	0.25	1.0	0.10	155	10	107	325	75	23.56
9	A20W11	JUWERE	58.03	27.47	56.0	0.25	1.0	0.20	205	10	130	412	73	29.42
10	A20W13	JUWERE	59.11	27.03	2.0	0.25	1.0	0.10	108	10	45	352	93	31.62
11	A20W14	JUWERE	59.11	27.03	9.0	0.25	1.0	0.20	1,090	10	136	345	115	12.30
12	A20W15	JUWERE	59.12	27.04	24.0	0.25	1.0	0.50	799	10	29	196	173	3.44
13	A20W18	JEGEDE	58.98	23.17	4.0	0.25	3.0	0.10	96	10	925	349	113	9.44
14	A20W20	JEGEDE	58.98	23.18	6.0	0.25	51.0	0.30	68	10	245	240	104	26.27
15	A20W23	JEGEDE	59.18	23.20	4.0	0.25	6.0	0.30	153	35	302	154	125	24.59
16	A20W25	MUCHACHA	62.50	25.95	3.0	0.25	4.0	0.30	79	10	334	145	84	16.10
17	A20W27	MUCHACHA	62.53	25.63	27.0	0.25	11.0	0.60	215	10	240	438	137	10.61
18	A3RW09	BENZI	61.90	37.12	7.0	0.25	37.0	0.30	66	10	552	299	155	24.81
19	A3RW10	BENZI	61.78	37.35	13.0	0.25	3.0	0.20	282	10	38	52	244	47.80
20	A50W01	RUPIRI	41.00	31.82	10.0	0.25	3.0	0.10	408	10	76	215	528	43.00
21	A50W02	RUPIRI	41.17	31.78	0.5	1.00	2.0	0.05	11	10	177	4	89	0.46
22	A80W01	FUMURE	18.58	18.17	0.5	0.25	6.0	0.10	14	10	8	12	29	9.88
23	A80W02	FUMURE	18.58	18.17	0.5	0.25	93.0	0.10	108	10	60	2,650	676	51.40
24	A80W03	FUMURE	18.58	18.17	0.5	0.25	38.0	0.10	223	10	1	480	111	46.60
25	A90K01	NYAHONDO	18.46	18.05	2.0	0.25	49.0	0.20	360	25	4	583	146	51.00
26	A90K05	NYAHONDO	18.35	17.85	0.5	0.25	21.0	0.10	258	31	1	396	114	50.80
27	C10K01	CHIPFUNDE	40.85	21.55	0.5	0.25	5.0	0.05	515	27	1	163	185	55.60
28	C10K05	CHIPFUNDE	41.25	21.60	8.0	0.25	12.0	0.20	742	29	30	101	558	55.80
29	RENCO	RENCO MINE	----	----	5,870	1.10	2.0	15.50	1,630	10	21	181	177	5.34
30	SPOT-01	SPOT MINE	----	----	5,770	1.10	2.0	15.20	1,870	10	25	259	22	4.32
31	SPOT-02	SPOT MINE	----	----	6,110	0.25	1.0	19.80	1,040	31	11	1	215	23.64

The selection of the mineralized signs was made by comparing various phenomena which are actually observed in the field with the results of collective survey discussions mainly made by Bohmke and Varndell (1986), Foster (1982), and Foster (1985), and with verified geological conditions around the Renco Mine and the Spot Mine. Generally, a good relationship is found between occurrence conditions of anomalies by geochemical exploration and that of mineralized signs.

Geological units on a geological map were limited to a mappable size.

Summary of mineralized zone and analytical results of samples taken from the areas were shown in TABLE 2-1-1 and TABLE 2-1-2.

1-1 ANGUS AREA

1-1-1 Survey methods

A semi-detailed geological survey on marshes and hills looking for float distribution is such a way that the relationship between the distribution of mineralized signs (described above), and the nature of geology and the geological structures could be determined.

As the continuity of the geological structures in this area was an ENE-WSW system(known from the previous survey), survey routes were selected by considering the geological structure.

1-1-2 Geology

General geology

The present area positions at the eastern end of the surveyed area.

Geological units: The area mainly consists of dolerite, felsic granulite and gneissose granulite (including charnockite). As outcrops are limited to small size ones observed in parts of the marshes in the area, no continuous outcrop suitable for elucidating detailed geological structure exists. These geological units also appear as a rock body extending to an ENE-WSW system.

Gneissose granulite (including charnockite) is most extensively distributed and occupies about 60% of the area. It is normally grayish to pale brownish in color, is composed of medium to fine grains, dense and hard, and has the remarkable foliation of an ENE-WSW system. Inclusion of garnet is common. This is white to pale grayish in color on weathered surfaces, yet has high resistance to weathering, compared with other rocks.

Felsic granulite is observed in north to south of the area, its distribution area occupies about 50%, it has a grayish color, and has a distribution extending to a NNE-SSW direction as well as gneissose granulite.

Dolerite shows the occurrence of dike form extending to the north and the south.

Geological structure

In this area there is excellent foliation in an ENE-WSW system. A tectonic line running north to south in the area is postulated from Landsat images and aerial photographs.

As FIG. 2-1-2 shows, a geological unit subjected to slight dislocation thereby can be supposed.

Mineralization

A mineralized sign (mainly composed of pegmatite quartz & K-feldspar) was only observed in the distribution region of charnockite and felsic granulite at the center of the area.

No other mineralized signs worthy of remark exist.

Note)
The classification of texture based on microscopic observation on thin sections has been performed in accordance with Bard (1986). As a result of the microscopic observation, we have found the texture from equigranular rocks to mylonite, which have been produced through tectonic metamorphism. The survey area is located in what is called the "Limpopo Mobile Belt" and has undergone strong tectonic metamorphism. Metamorphism had developed in the area, so that we considered it possible to classify rocks by texture. In this report, therefore, we have classified rocks into the following seven types of texture, paying attention to fine and uniform granualtion of minerals, which are found in thin sections.

(1) Isogranular	0
(2) Polygonal	0
(3) Heterogranul	0
(4) Framed Porphyroblastic	1
(5) Protomylonitic	2
(6) Augenmylonitic	3
(7) Ribbon Quartz	4

The isogranular, polygonal, and heterogranular types of texture are slightly different from one another and have not undergone tectonic metamorphism. Since no fine granualtion of minerals has developed in such types of texture, we have designated them tectonic grade 0. The framed porphyroblastic texture has been designated tectonic grade 1 because the texture has been formed after rocks at the stage of tectonic grade 0 underwent tectonic metamorphism and after the fine granualtion of minerals commenced.
For the protomylonitic texture, finely granulated minerals increase further in volume and almost no original texture is found. Therefore, this stage has been designated tectonic grade 2.
For the augenmylonitic texture, minerals in the original rock are finely granulated to about 0.1 mm or less in diameter and such granulated minerals are contained at larger volumes than that of potassium feldspar which has been left in an eyeball shape. This stage has been designated tectonic grade 3.
For the ribbon quartz texture, the augenmylonitic texture has undergone tectonic metamorphism and quartz is arranged in a ribbon shape. This stage has been designated tectonic grade 4.

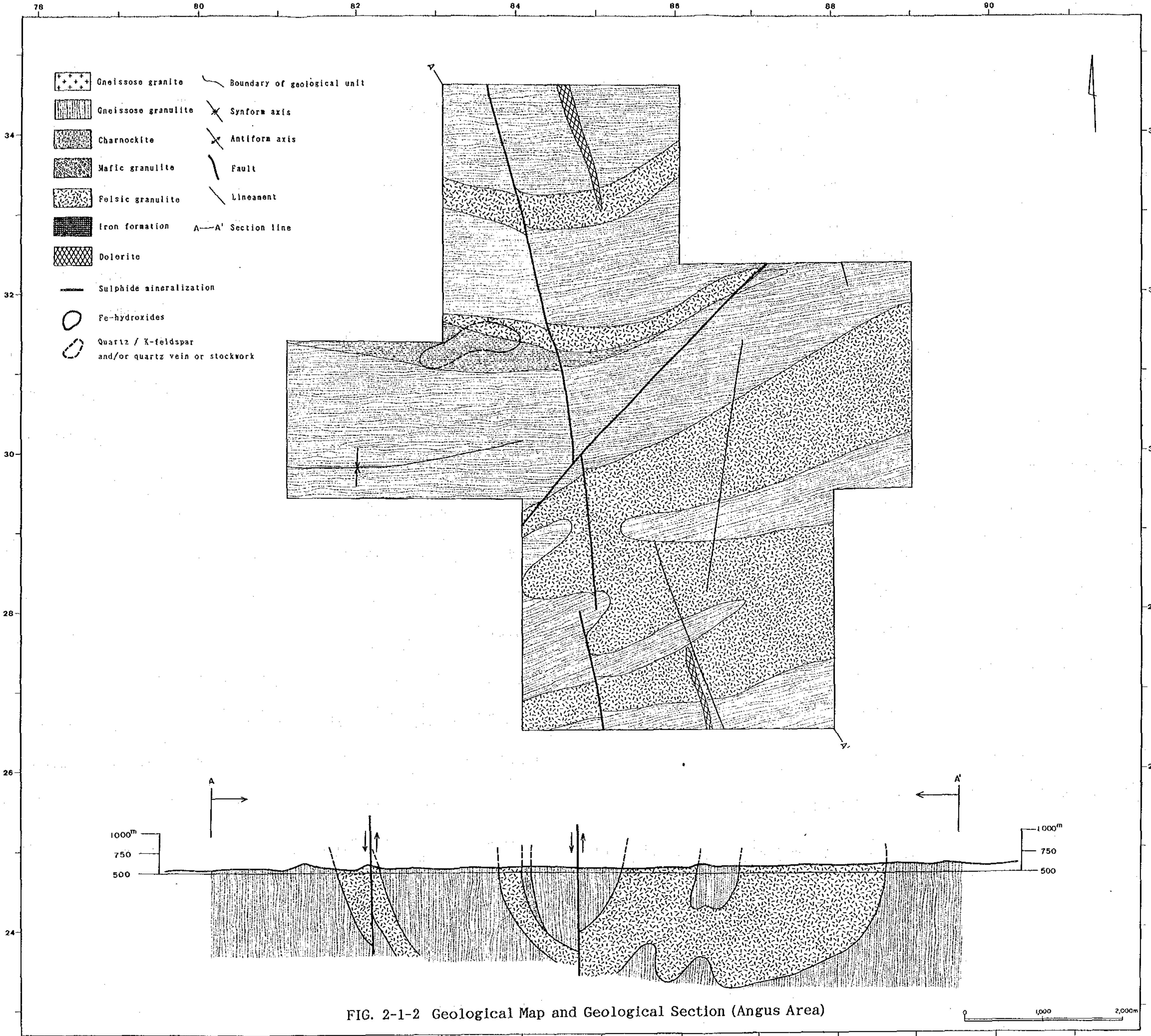

FIG. 2-1-2 Geological Map and Geological Section (Angus Area)